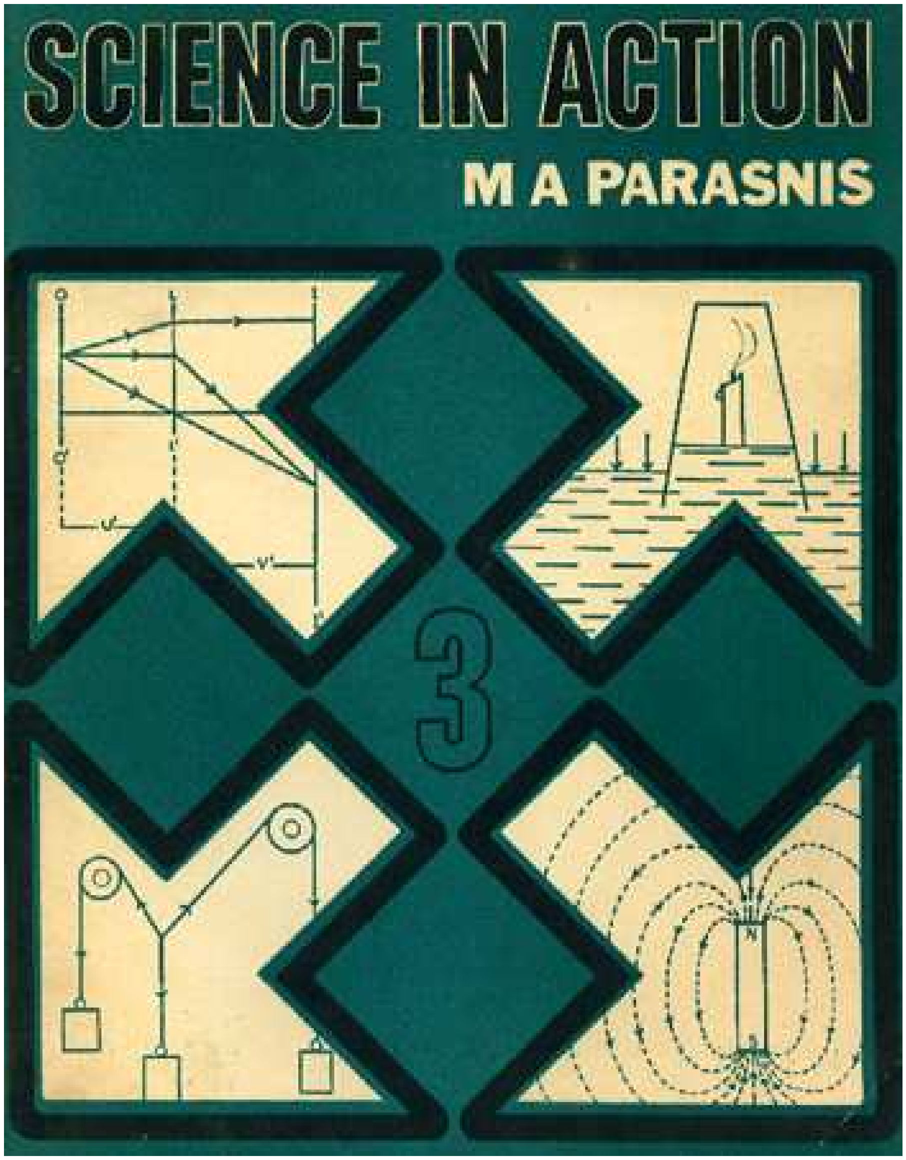

SCIENCE IN ACTION

M. A. PARASNIS

BOOK 3

Published 1976

PREFACE

Doing an experiment is fun
And is the best way to learn

The series 'Science in Action' is written specially to help children in the age group eight to thirteen years to have first hand experience in science. It is designed so as to help the classroom teacher make the learning of science an enjoyable and rewarding experience for herself/himself as well as for her/his class. Interested parents could also easily use the series to help their children to do science at home. Enthusiastic children could even use it on their own at home and school.

The series consists of five books: Book I for class four (age 8-9 years), Book II for class five (age 9-10 years), Book III for class six (age 10-11 years), Book IV for class seven (age 11-12 years) and Book V for class eight (age 12-13 years). It is not designed to cover the syllabus of any particular school system or state but, rather, to uncover a little part of the fascinating world of science, taking into consideration the average mental and physical capabilities of the respective age groups.

Essentially these are books of science activities. These typical activities, selected from various areas of science, use *readily available* and *Inexpensive materials* like jam and milk bottles, coffee tins, paper cartons, thread, string, wire, paper clips and pins, rubber bands, balloons, drinking straws, etc. Many classic experiments, described in text books unchanged for generations, have been performed more interestingly and instructively. Many more have been added. Each activity has been tried and tested out, so to say, in the *field.* They all involve experimentation resulting in experience with important scientific principles. The involvement is qualitative and thus maintains a high level of interest.

These books are the culmination of a decade of involvement in school education (on the campus of the Indian Institute of Technology Kanpur) into which I was initiated and inducted by the Institute's first Director, Dr P K Kelkar. It was his faith in the tremendous potential of children and his keen insight into the way they learn which 1 made him start a school on the campus under IIT/K Administration. The School had complete freedom to try out new methods in teaching and learning. It was at the IIT/K Campus School that many of the seeds of the present series were sown. It was the encouraging response from children and teachers of that school that gave me the enthusiasm to complete the work.

Thanks are due to the Education Development Centre, IIT/K, funded by NCSE/NCERT, for grants which have supported this venture and have made it possible for each and every activity in this series to be actually tested out.

For books such as these good illustrations are essential. They save many words of description and are a special attraction for the children. I would like to record my appreciation for the patient and painstaking work done on illustrations by Mr. A C Joshi of the Department of Electrical Engineering, IIT, Kanpur.

My husband, Dr Arawind S Parasnis, Professor of Physics, IIT, Kanpur, has read the manuscript critically and made innumerable valuable suggestions. He and my sons, Kaushik and Gautam, have provided that understanding cooperation without which I could not have enjoyed writing the series. My sons were often the guinea pigs for testing out these activities.

The series is dedicated to children—the mini-scientists—and their teachers. If you have enjoyed the books, do let me know along with corrections and comments, if any.

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INTRODUCTION

Science today plays a significant and ever-increasing role in the social and economic life of ordinary man. The impact of scientific and technological progress not only has permeated urban and suburban life but also is fast penetrating into remote villages. New varieties of seeds, the tractor, the transistor radio and the antibiotics have reached the farthest corners of our country. Many villages have been electrified. Satellite Instruction Television Experiment (SITE) has already taken television to a number of villages. Training in science is essential to the improvement of health and living conditions of our people and to the promotion of agriculture and industry. It is, therefore, increasingly important for everybody to be literate in science. This need embraces all age-levels, alt socio-economic levels and all intelligence levels. However, it is for the children of today, the arbiters of our fate tomorrow, that the need is the greatest. Unless we give our children scientific schooling we cannot hope for a bright future for our country.

Till very recently, no one studied science unless one entered middle/high school. Some schools did teach a few lessons about birds and flowers. All that was available was a few books of nature stories and study.

Since Independence the field of science education has undergone a big change. Most of the changes stem from a dual attempt. First, there has been

an increase in the quantity of subject matter taught. Second, there has been an attempt at re-establishing the class levels at which various topics would be taught: a part of what was done in high school is now sought to be done in the middle school and, in the same way, a part of what was done in the middle school is sought to be handed over to the primary school.

However, students are doing more reading in science. They are reading about science but not doing science. This is like attempting to teach a person to swim by having him read the best books on swimming rather than plunge into water.

In short, the science programme in our schools is still around the text books. Science is viewed by teachers (and consequently by children) as a body of facts and a set of answers, absolute and immutable, which explain the universe. Often these explanations come in the form of one word or phrase taught by the teacher and learnt by heart by the taught. When a phenomenon is demonstrated, the children simply associate the questions about the phenomenon with the word or phrase without understanding conceptually the interactions involved. Natural phenomena are used not as stimuli to regenerative thinking and to the spirit of discovery but merely as examples of or adjuncts to facts already presented. Thus a bug floating on water is an example of surface tension. A ship, though made of steel, floating on the sea is an example of Archimedes' principle. The horse pulling the cart and the cart pulling the horse is an example of Newton's law of reaction. Can we blame the child?

This inevitably helps erect a barrier between the child and science. This barrier must be broken. When such barriers are broken science becomes not only interesting but also a part of the child's thinking. This requires a child's active involvement in his own learning. Experimenting is an excellent chance to stimulate thinking. There is joy and excitement in working with one's own hands for man is basically a builder. Children need to work with their own hands and talk and argue about their work. They should get involved with science and discover its principles for themselves. As far as possible, even demonstrations by teachers should give place to investigations by children. Children should work like little scientists busy exploring the rich world around them. It was a very wise Chinese sage who said

I hear and I forget

I see and I remember

I do and I understand

Performing experiments and learning to make close observations requires some facilities. These are lacking in most of the schools of our country—especially at the primary and middle school levels. As a result, science teaching (if it is attempted at all) suffers from a severe handicap especially at these levels. It is often believed, though erroneously, that to introduce science experience even in primary and middle schools requires elaborate equipment made by commercial manufacturers and hence needs a big budget.

The series 'Science in Action' is an attempt to use simple, easily *available, low cost materials* to set up experiments which illustrate a large variety of sophisticated scientific principles. For example, experiments are so designed that the child does not need to use wooden planks, hammer and nails; the same work is done by cardboard, bark cork and drawing pins. The experiments are not hard to set up even if you have not done much experimentation before. The series is meant for classes' four to eight and consists of five books. These are essentially books of science activities written in a simple style so as to provide teachers, teachers-in-training and children with a variety of experiments that can be used as teacher-demonstrations, children's class room activities, demonstrations at science fairs, class projects or any related science study. The activities are interesting and instructive in practical and exciting ways.

From this year the 10 + 2 + 3 pattern of education is being introduced and science and work experience courses are compulsory up to class 10. The activities in these books involve both science and work experience. A good deal of the material needed has to be built with tins, cardboard and string. Screw driver, hammer, hacksaw, cork-borers, files and planers have to be used, depending upon the level. The contents of each book can be covered during a one year period by allotting special 'activity periods' during which children will work with their own hands to produce materials with which they will learn science. Book I has 25 very simple activities which could easily be handled by children of class 4 with two periods a week. This could be increased to four periods a week for classes 5 and 6 (Books II and III which have 30 and 40 activities respectively) and six periods a week for classes 7 and 8 (Books IV and V, having 45 and 50 activities respectively). Many concepts have been repeated from book to book so that a concept can grow to a greater degree of sophistication as a child goes to higher classes.

Each activity has five parts:

(i) An attractive title

(ii) Materials: the things and the equipment needed to perform the activity

(iii) Procedure: Step by step utilization of the materials. The expected observation is usually indicated as a part of the procedure

(iv) Drawings and diagrams: for ease of assembling

(v) The ‘why’ of the activities is given sequentially at the end of each book. This gives scope to the child to think for herself/himself. In case she/he needs help it is readily available. This also acts as a check.

Believing that the method of science should play a significant role in any modern educational scheme, this series is offered in the hope that it will assist science teachers and students in their co-operative quest for science.

FOREWORD

It is a matter of great pleasure and honour to have this opportunity of writing a Foreword to the rather unique series of books entitled ‘Science in Action’ meant for children below thirteen years of age written by (Mrs) Meera A Parasnis, The time of its publication could not have been more appropriate for there seems to be a new awareness in the country of the need to make science education meaningful from the earliest level of schooling right up to the tenth standard.

Modern technology is revolutionising our entire social structure in a variety of ways. The pace of change poses challenges in every direction. It is possible neither to go back nor to advance in a systematic manner without a proper understanding of the way technological forces affect society. It is necessary to appreciate that if the fruits of technology enter the lives of men; its roots are in science. In this context understanding of science and the scientific method is as necessary for those who are going to be professional scientists as for the rest.

The essential objective of the teaching of science to children must be not so much the imparting of scientific information as creating a lively interest in the scientific method and developing a scientific attitude of mind by actual involvement in “scientific activity”. This is precisely what this series of five books makes possible.

In this approach the material expenses involved are very modest, but it draws heavily on the motivation of the teachers and the taught. To observe, to ask questions, to use Imagination, to make intelligent guesses about the possible answers, are all attributes of a lively scientific attitude of mind.

There is little doubt that, if children are exposed to these activities as detailed in these books over a sufficient period of time, they will not only be familiar with the scientific method but will develop a scientific attitude of mind. Children successfully taught in this fashion will in fact begin to show the scientific approach in all their learning.

Mrs Parasnis has taken enormous pains in writing these manuals based on ten years of her direct involvement with children in the age group of 8- 13 yrs, in exposing them to real scientific activity. The material incorporated has been as though tested ‘in life’ and that is perhaps its greatest merit. In my view, Mrs Parasnis not only deserves congratulations but our gratitude for this timely publication.

If the experiment involved in using these manuals succeeds, as it should, then no time may be lost in making these available in various Indian languages.

P K KELKAR

“Chhaya”

H R. Mahajani Marg

BOMBAY 400 019

CONTENTS

1 Let us weigh Air

Materials

Metre Scale

*Drilling machine**

Thread (or wire)

Empty tin

Foot ball (or Basket ball) bladder

Mustard seeds (or rice or sand)

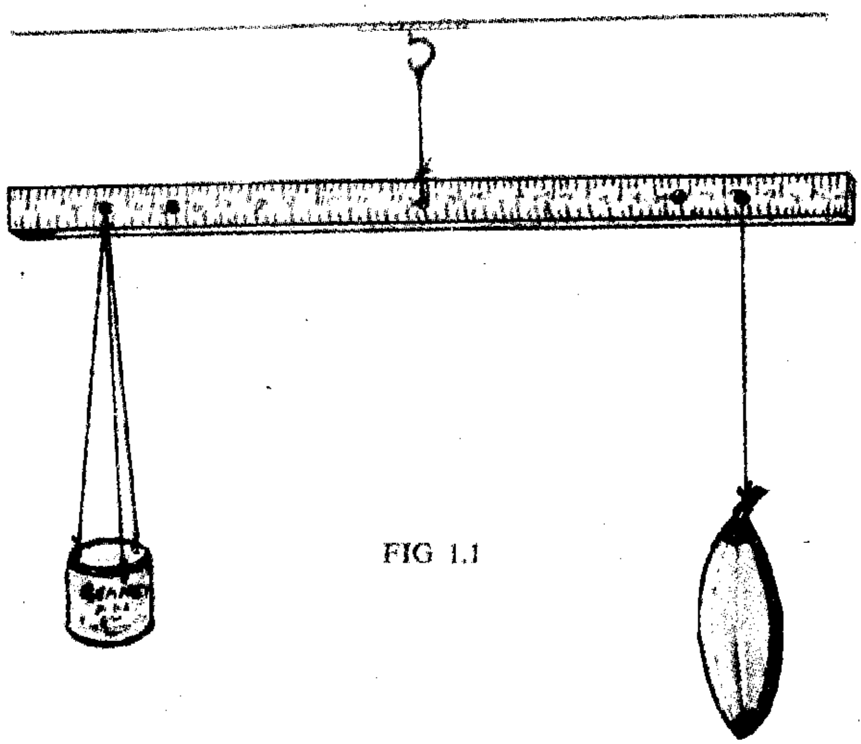


FIG 1.1

Take a metre scale and find the point where it balances on a pencil. This point will be at or near the 50 cm mark. Use a drilling machine to make a hole at this point. Tie a piece of thread by passing it through the hole. You now have a *balance beam.* You can hang the beam by the thread.

Make holes 10-12 cm from either end of the beam. Use thread and hang a tin from one end of the beam. Hang a football bladder from the other end.

Hang the beam from a hook and pour mustard seeds into the tin to balance the weight of the bladder *(Fig 1.1).*

Work away from air currents.

Now untie the bladder from the beam and blow it up as hard as you can. Again hang it.

∗If you do not have a drilling machine, you could make a hole with a hammer and a nail. You could even tie up a string directly around the point without making a hole.

What do you observe?

The bladder end goes down *(Fig 1.2).*

You will have to add some more seeds to balance the beam again.

Why?

Now make holes 20 cm from either end. Repeat the experiment.

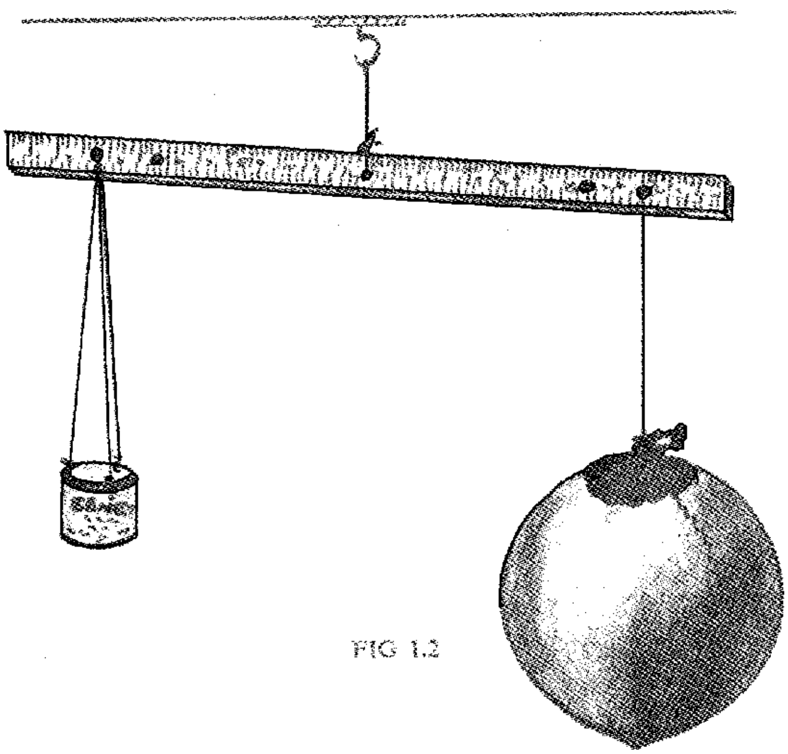


FIG 1.2

Next hang the tin from the 10 cm hole and the bladder from the 20 cm hole. Again repeat the experiment.

What do you find?

Every time you blow the bladder, the balance is disturbed and you have to add more seeds to balance the beam.

2 Crush a Plastic Bottle without squeezing

Materials

Plastic bottle with a screw cap Hot water

Cold water

Heating arrangement

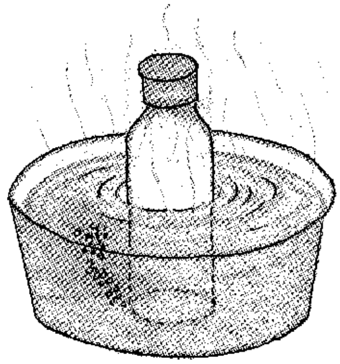


FIG 2.1

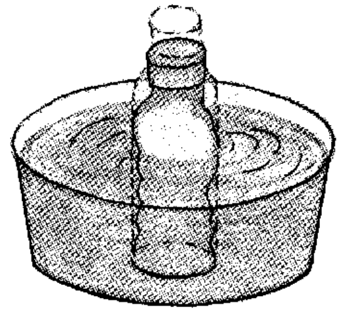


FIG 2.2

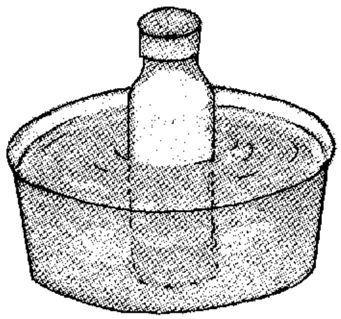


FIG 2.3

Take a plastic bottle with a screw cap.

Make a *pin hole* on the side and near the bottom of the bottle. (Pricking with a hot needle works well.)

Screw the cap on the bottle and place it in hot water. Watch.

A stream of tiny air bubbles are forced out of the hole and rise in the water *(Fig 2.1)*

Why?

Quickly plunge the bottle into cold water.

What do you see?

The bottle gets *suddenly* crushed *(Fig 2.2)*.

Why?

Wait and watch.

What happens?

The water enters through the hole and the bottle *slowly* blows up to its original shape *(Fig 2.3)*.

Why?

3 Hold water in Inverted Tumbler

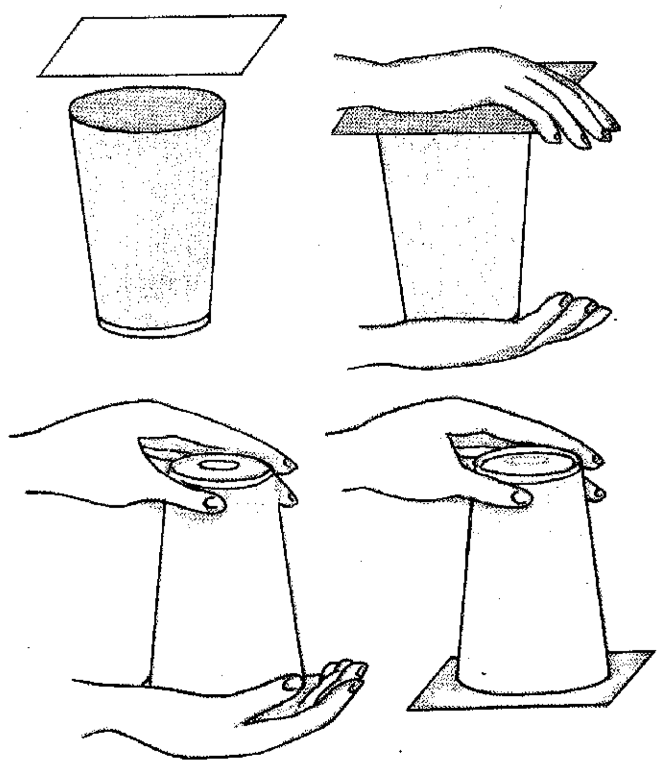
Materials

Glass (or Plastic) tumbler

Water

Thin card

Basin (or sink)*



Fill a tumbler *completely* with water.

Place a piece of card (not too thick) on the top of the tumbler *(Fig 3.1)*.

Hold the glass on the palm of your left hand and keep the card in place with your right hand *(Fig 3.2)*.

Invert the tumbler *quickly (Fig 3.3)*.

Remove your right hand *carefully* so that *no air enters* between the card and the tumbler *(Fig 3.4)*.

What do you see?

The water *remains* in the *inverted* tumbler.

Why?

Turn the tumbler sideways. The water still remains in it.

Why?

*Work over a basin to avoid a mess in case the water spills around.

4 The Egg pops into a Bottle

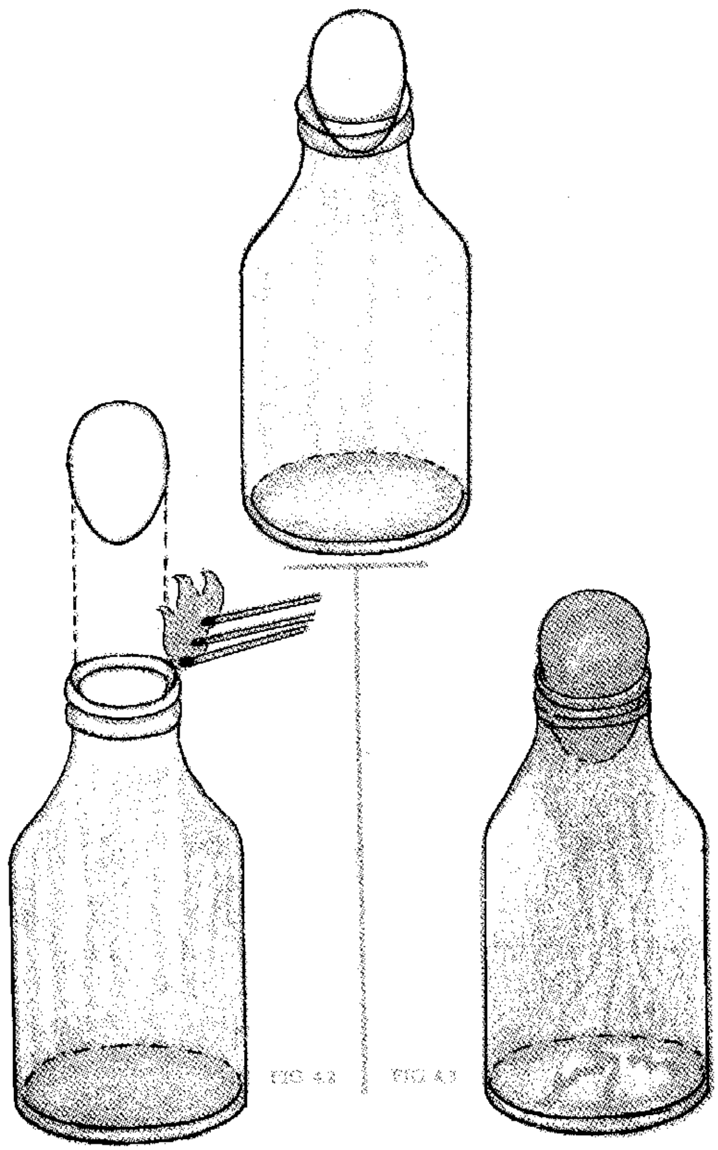
Materials

Egg

Boiling water

Milk bottle (empty)

Box of matches



Gently place an egg in boiling water. Allow it to boil for 8-10 min. You now have a *hard-boiled egg*. Remove the shell.

Keep the boiled egg on the mouth of an empty milk bottle. It does not go in. It is *somewhat bigger* than the mouth of the bottle* *(Fig 4.1)*.

Now light two or three match sticks. Drop the burning match sticks into the bottle and then place the boiled egg on the bottle *(Fig 4.2)*.

In a few moments the egg *pops* into the bottle *(Fig 4.3)*. Why?

You may have to choose the egg of the proper size.

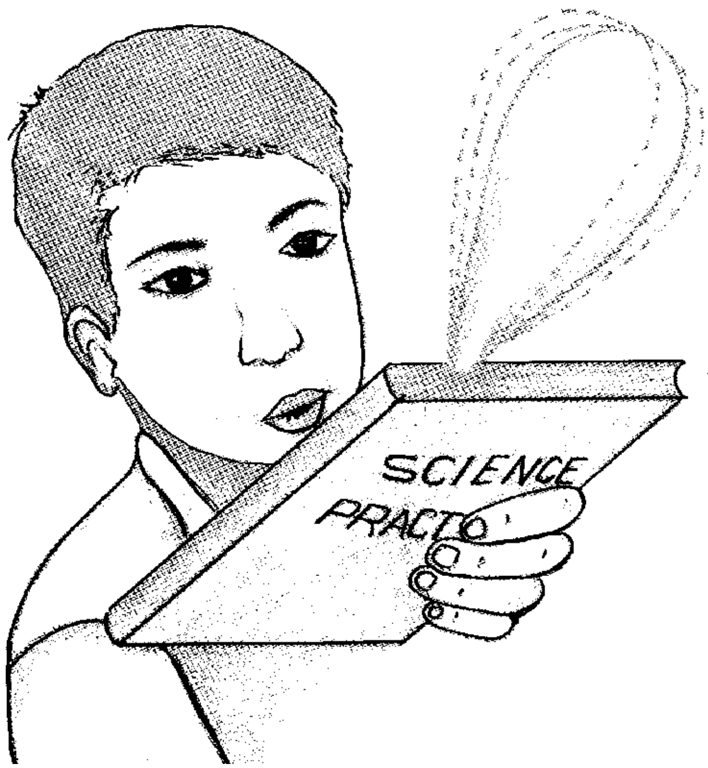
5 Balloon lifts up when you blow over it

Materials

Rubber balloon (preferably long)*

Sewing thread

Book



Take a long rubber balloon and blow into it. Tie the neck of the balloon with a piece of thread.

Put the neck of the balloon inside a book.

Blow hard along the surface of the balloon.

What do you expect?

What do you see?

The balloon rises in spite of your blowing *over* it *(Fig 5)*.

Do you know why?

*You could use a strip of paper 25 cm x 5cm   instead of balloon.

6 Paper refuses to obey Gravity

Materials

Empty spool of sewing thread

Thick paper

Pin

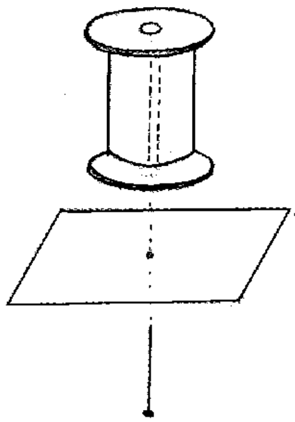


FIG 6.1

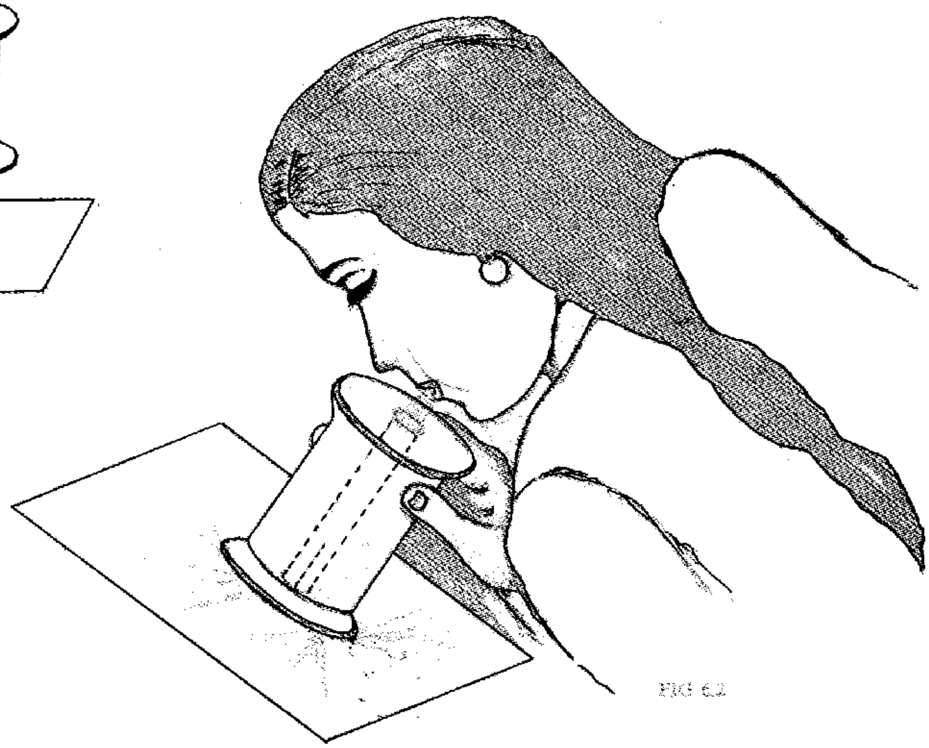


FIG 6.2

Take an empty spool of sewing thread.

Cut out a piece (card) from thick paper.

Push a pin through the centre of the card *(Fig 6.1)*.

Keep the card on your outstretched palm with the pin pointing upwards. Place the spool on the card so that the pin is in the centre of the hole.

Blow hard downwards through the hole in the spool.

Keep blowing and take your palm away.

What do you see?   What did you expect?

The card refuses to fall *(Fig 6.2)*.

Why?

7 See the effect of *Streamlining*

Materials

Thick paper

Candle

Box of matches

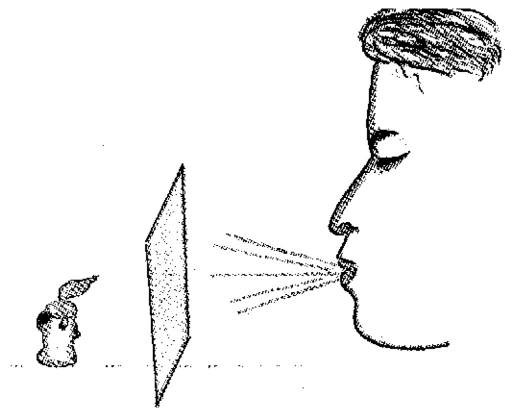


FIG 7.1

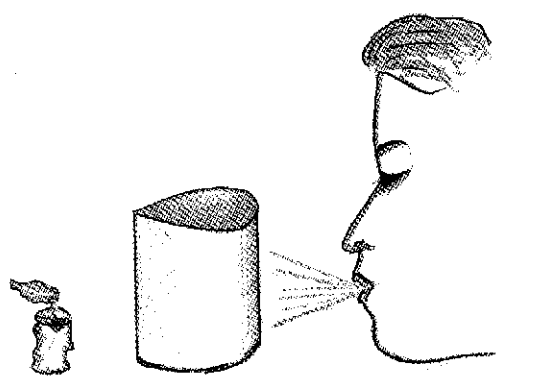


FIG 7.2

Cut a square piece of thick paper, and hold it in front of a lighted candle.

Blow a current of air towards the paper.

Observe what happens to the flame of the candle *(Fig 7.1)*.

The flame is blown *towards* the paper.

Why?

Next take a piece of paper about 15 cmx30 cm.

Fold it into a *streamlined* shape as shown in Fig 7.2.

As before, blow towards the paper.

Note the direction of the flame.

The flame now bends *away* from the paper *(Fig 7.2)*

Why?

Do you know how this is used in racing cars and aeroplanes?

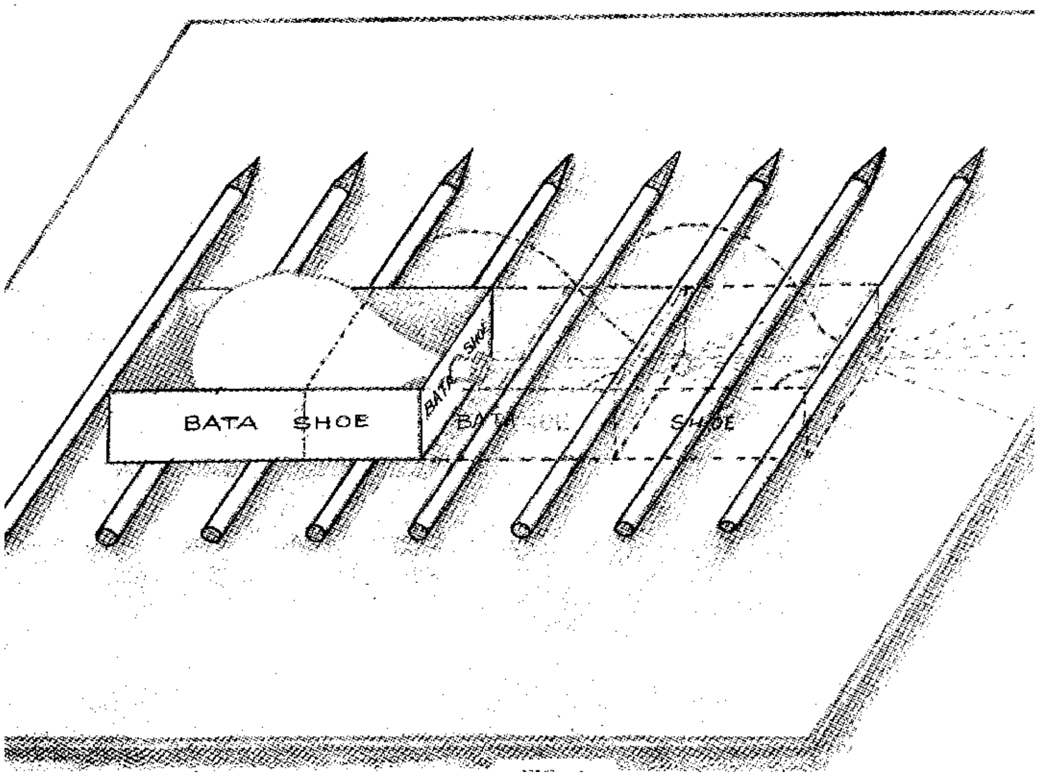
8 Shoe Box Rocket

Materials

Cardboard box with small height

Balloon

Round pencils



Take an empty shoe box and cut its height to about 5 cm. If you don't have one, make one from cardboard.

Cut a hole at one end of the shoe box, large enough to hold the neck of a balloon without letting its slip out.

Spread 8 to 10 round pencils parallel to each other on a *smooth* table.

Place the balloon in the box and pass its neck through the hole.

Inflate the balloon. Pinch its neck with your fingers so that the air does not escape.

Place the box on the pencils.

Release the neck of the balloon.

What happens?

The box moves rapidly over the pencils *(Fig 8),*

Why?

Note the direction in which the box moves.

What is the role of round pencils?

9 Rubber Band Gun

Materials

Long piece of wood (or wooden scale)

Three nails

Long thick rubber band

Thread

Small stone (or any suitable object)

Two empty cylindrical tins (plastic or tin or cardboard)

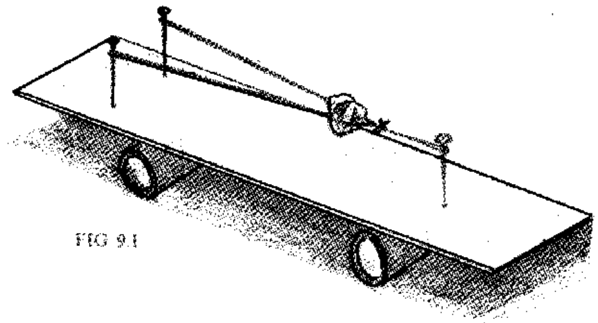


FIG 9.1

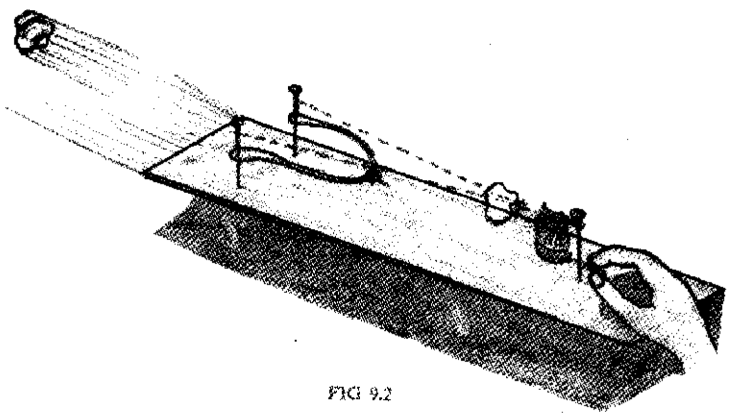


FIG 9.2

Fix two nails side by side near one end and a third nail near the other end of a long piece of wood about 30 cm x 4 cm as shown in *Fig 9.1*.

Tie a loop of thread to the rubber band. Pass the rubber band around two nails that are side by side and the loop over the third nail such that the rubber band is stretched.

Hold a stone in the stretched rubber band. The stone is the shell. Place the whole set-up (rubber band gun) on two plastic tins *(Fig 9.1)*. Burn the loop of thread without touching the gun *(Fig 9.2)*. What do you see?

The rubber band contracts, the stone shoots forward and the gun moves backward.

Why?

10 The Car and the Cardboard Road

Materials

Stiff cardboard

6 or 7 round pencils

Table

Toy car

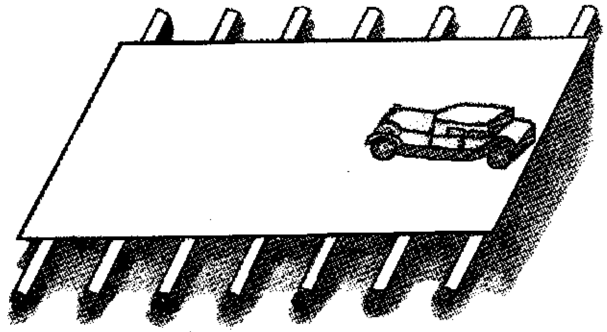


FIG 10.1

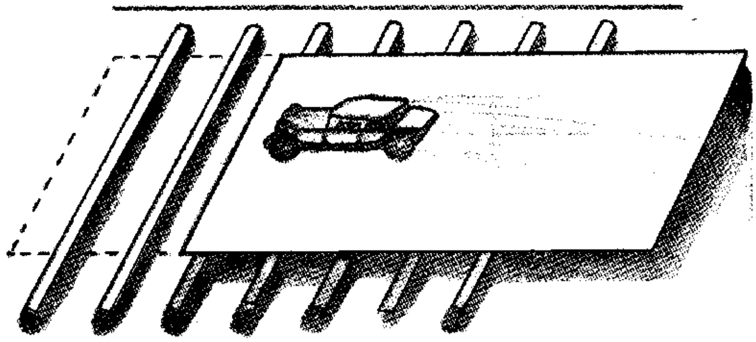


FIG 10.2

Take a stiff cardboard about 20 cm x 40 cm.

The stiff cardboard is your ‘road’. Spread 6 to 7 round pencils evenly on a smooth table (or floor). Place the cardboard road on the pencil rollers.

Take a toy car and wind its spring.

Place the car on the road. Make a mark X on the *table* to indicate the position of the car *(Fig 10.1).*

Release the spring of the car. See what happens.

The toy *car* moves *forward.* At the same time the cardboard *road* moves *backward (Fig 10.2).*

Why?

Can you tell why the earth does not seem to move when so many cars and people move on the earth?

11 Obedient Tin

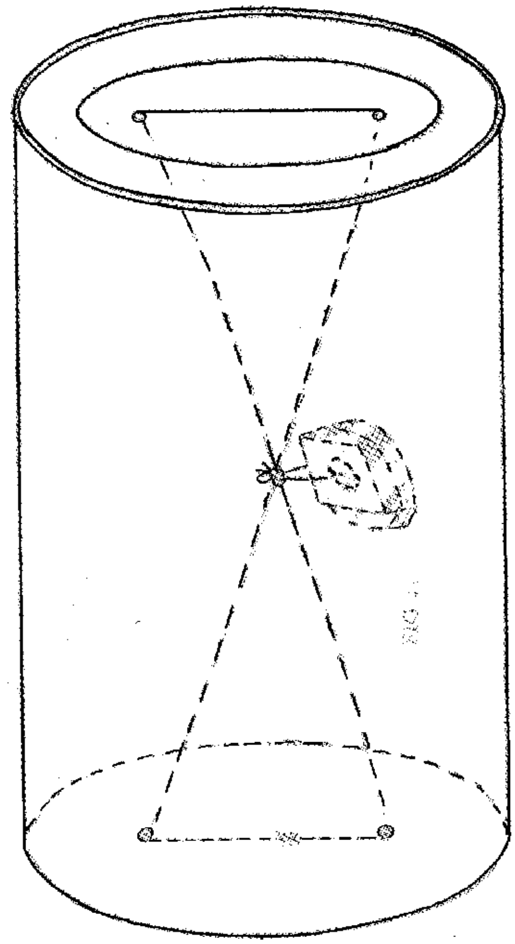
Materials

Two identical tins with lid (coffee, chocolate, etc)

Thick rubber band

Small heavy weight (e.g. nut)

String



Take two *identical* tins.

Make two holes in the lid and two in the bottom of one of the tins.

Cut a rubber band to give you a rubber cord.

Stretch the rubber cord, pass it through the holes and tie it on one side. With the string tie a heavy nut to the two strands of the rubber cord *(Fig 11).*

Your obedient tin is ready.

Roll both the tins across the floor.

What do you see?

The *obedient tin comes back* to you. The *other tin rolls on.*

Why?

Repeat a number of times.

12 Meeting of Fingers

Material

Smooth stick (metre scale, ruler, etc)

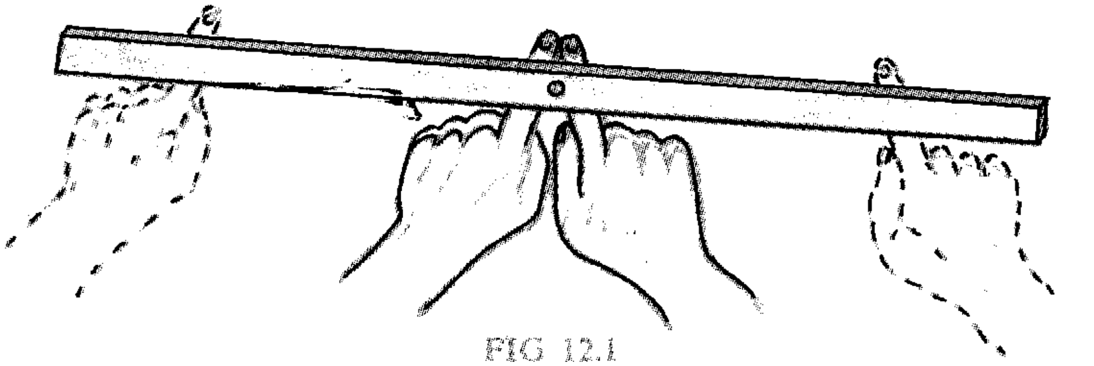


FIG 12.1

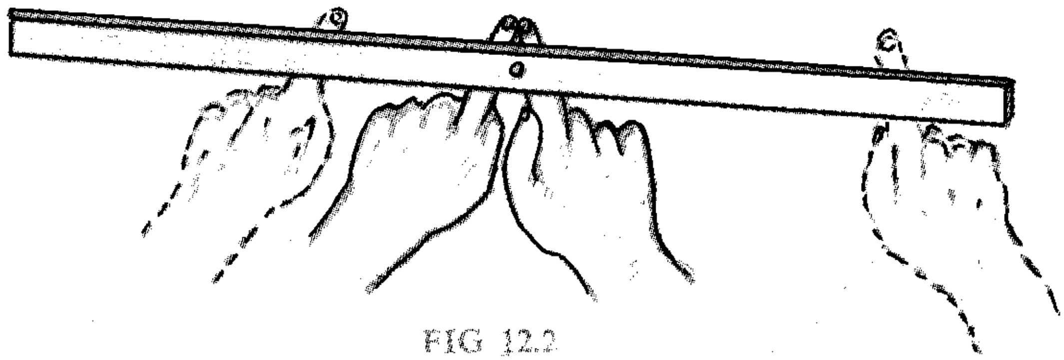


FIG 12.2

Put your palms facing down and stretch *only* the fore fingers.

Let a friend place a smooth stick on the fingers. Let the fingers be near the ends of the stick.

Slowly move the fingers towards each other. Where do your fingers meet on the stick *(Fig 12.1)?*

Place the finger of your right hand near the end of the metre stick and the other finger nearer to the centre on the other side. Again move your fingers *(Fig 12.2).*

Where do the fingers meet this time?

Change the initial position of your fingers a number of times and repeat.

Each time the fingers come together at the *centre* of the stick. Why?

13 The Tin rolls uphill

Materials

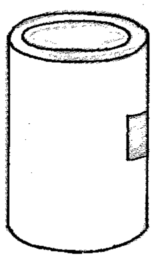
Empty tin with lid

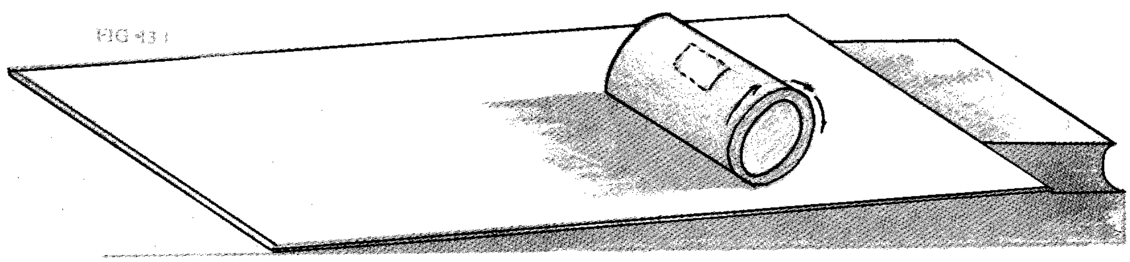
Small heavy weight (nut or bolt)

Cello tape

Long board

Books





Tape a heavy weight on the inside surface of a tin, half way between the top and the bottom.

Put the lid *on (Fig 13.1).*

Make a mark on the outside to indicate the position of the weight.

Make a small inclined plane using a long board and a book.

Hold the tin on the incline so that the weight is *high up and slightly towards the uphill side.*

Let go.

What do you see?

The tin rolls uphill *(Fig 13.2).*

Can you tell why?

Does the tin not obey gravity?

Now use two books to increase the angle of the plane. Does the tin go as far?

14 Heat shrinks Rubber

Materials

Long rubber band

Small tin filled with sand (or any object)

Horizontal support (e.g. clamp stand)

Candle

Box of matches

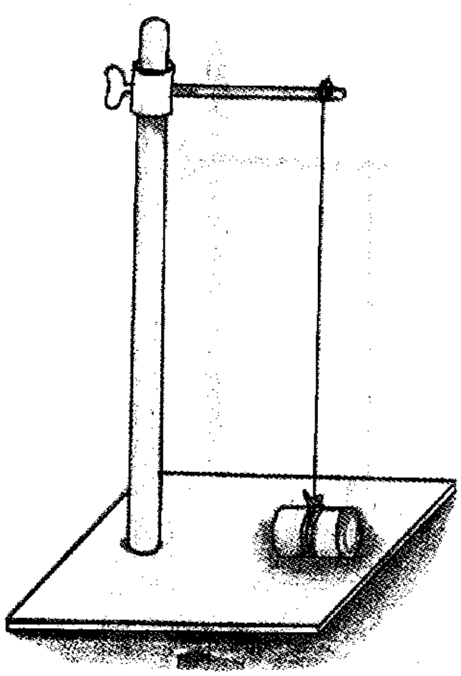


FIG 14.1

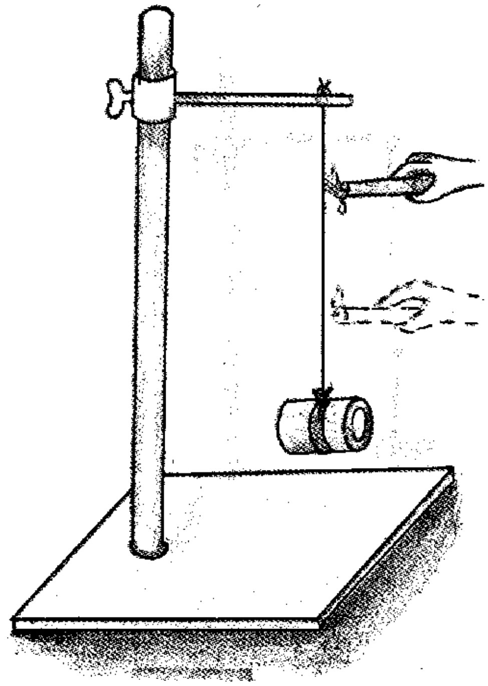


FIG 14.2

Cut a long rubber band and you get a rubber cord.

Tie one end of the rubber cord to a tin filled with sand. Hang the tin from a clamp stand (or any horizontal support) so that the tin just touches the base *(Fig 14.1)*.

Heat the rubber cord by playing the flame of a candle up and down *rapidly* along the cord. Do not burn the rubber.

What do you observe?

The rubber cord becomes shorter and the tin rises up *(Fig 14.2)*.

Why?

15 Conduction of Heat

Materials

Heavy gauge copper (or iron) wire about 25 cm long

Cork

A little wax

Candle

Box of matches

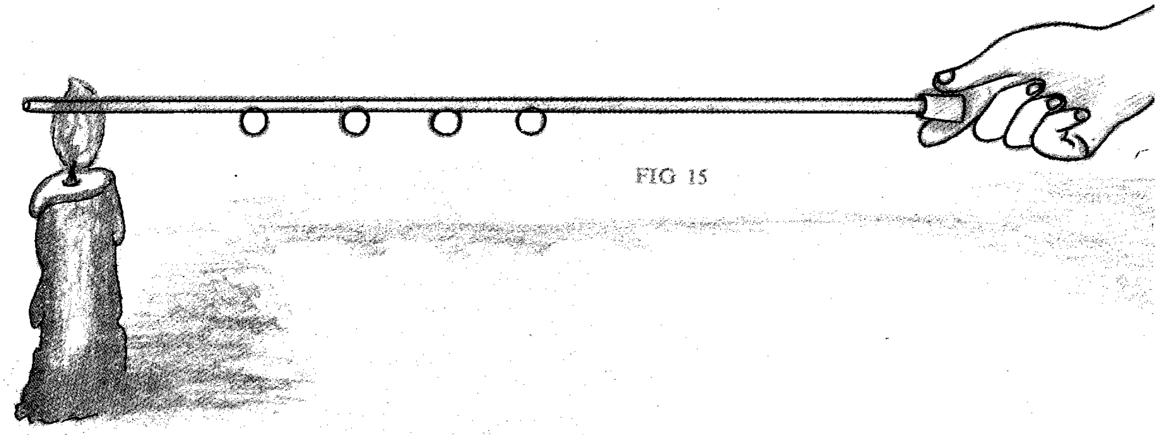


FIG 15

Take a *thick* copper wire about 25 cm long. Fix a cork at one of its ends.

Starting about 4 to 5 cm from the other end of the wire, fix several balls of wax at about 2 to 3 cm intervals.

Hold the wire by the cork and heat the other end in the flame of a candle *(Fig 15)*

What do you observe?

The first ball to melt and drop is the one nearest to the flame. The other balls fall one after the other.

Why?

16 They change Places

Materials

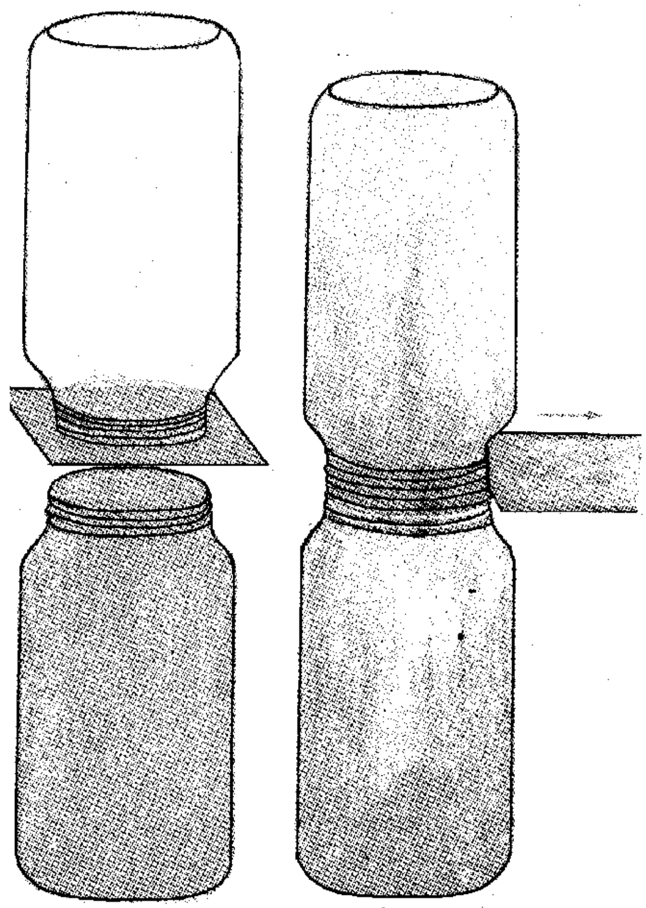
Two identical clear bottles (jam or milk)

Hot water

Cold water

Ink (or any other colouring matter)

Piece of cardboard



Fill one of the two identical bottles with *coloured* hot water and the other with cold water, both to the brims.

Place a piece of cardboard over the bottle of cold water. Hold your hand firmly over cardboard and invert the bottle *(Fig 16.1).* Place it carefully on top of the bottle of hot water so that their mouths are exactly one above the other.

Remove the cardboard while holding the upper bottle.

Watch. What do you see?

The coloured hot water rises up.

The cold water goes down and takes the place of the hot water.

They change places *(Fig 16.2).*

Do you know why?

Repeat the activity using cold salt water and cold coloured fresh water.

They also change places. Why?

17 Expansion Race

Materials

Two identical bottles with small mouths

Two rubber stoppers each with a hole to fit the bottles

Two identical glass tubes to fit the above stoppers

Water

Alcohol (or methylated spirit)

Hot water bath

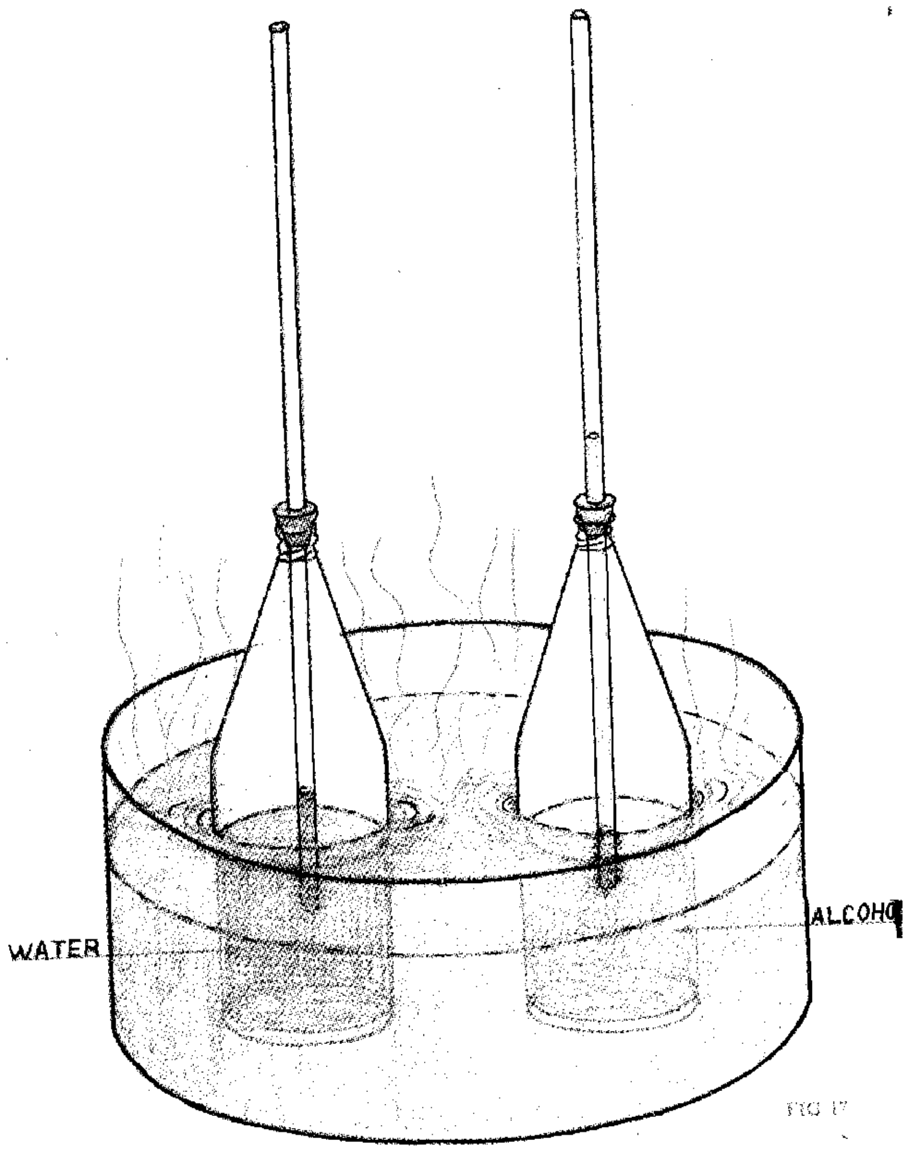


FIG 17

Take a bottle with a *well fitting* rubber stopper. Make a hole in the rubber stopper and fit a long glass tube in the hole.

Prepare one more identical bottle similarly.

Fill one bottle with alcohol (or spirit) and the other with water. Replace the rubber stoppers. Make sure that the *liquid level is above the end of the tube in each bottle.*

Place both the bottles in a dish containing very hot water. What do you see?

In a short time the liquid in each tube will rise. Why?

Note which rises *faster* and higher and wins the race. Alcohol wins the expansion *race (Fig 17).* Why?

18 What burns in a Candle?

Materials

Candle

Box of matches

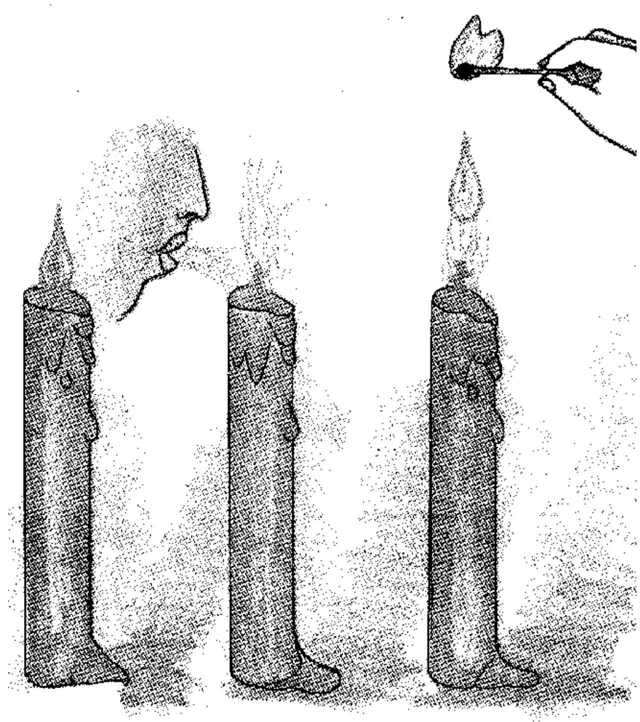


FIG 18.1 FIG 18.2 FIG 18.3

Light the candle and let it burn for some time *(Fig 18.1)* Now blow it out *(Fig 18.2)*

Immediately after the candle goes out, hold a lighted match stick 2-3 cm *above* the extinguished flame.

What do you see?

The candle lights up again *(Fig J8.3)*.

Why?

Now wait for some time after the flame is blown out and then bring a lighted match.

What happens?

The candle does not light up.

Why?

19 Tin Telephone

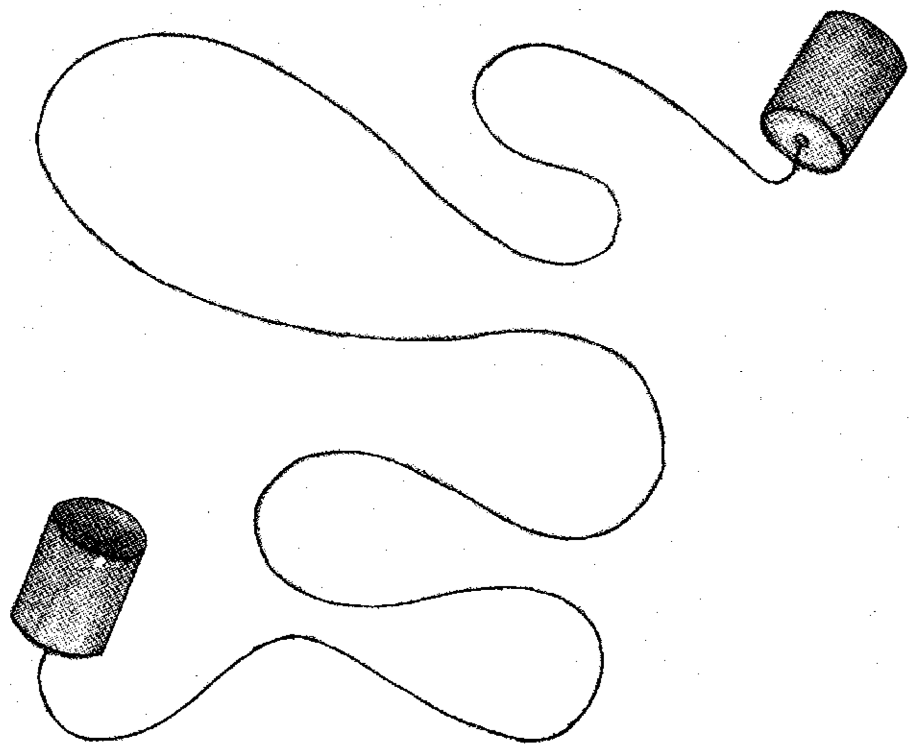
Materials

Two empty tins

String Wax (not necessary but desirable)

Two buttons (or button-size pieces of tin or aluminium foil)

Thin nail with a sharp point



Take two empty tins without lid.

With a thin sharp nail, make a small hole in the centre of each tin at the bottom.

Run wax up and down along a convenient length of string, say 3m. Pass the waxed string through the holes in the tins.

Tie a button at each end of the string. This will hold the string firmly in the tins *(Fig19)*.

Let a friend hold one tin and you hold the other tin far enough so that the string is taut (tightly stretched).

Let one of you speak into his tin and the other listen by the other tin. You can have a secret talk with your friend.

Isn't it fun?

How does it happen?

20 Singing Spoon

Materials

Spoon

String

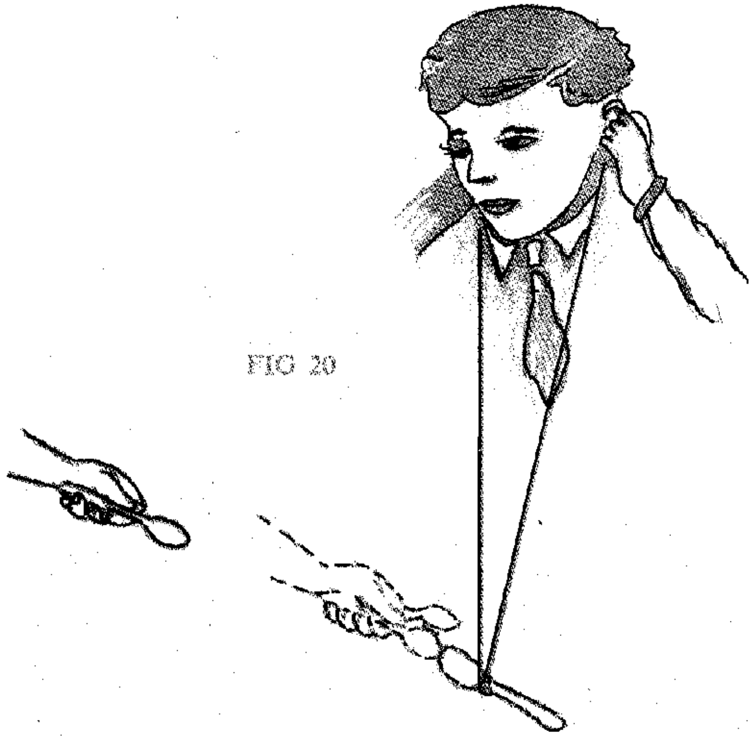


FIG 20

Cut about 1 meter length of a string.

With both ends of the string together, balance a spoon in the loop formed in the string. Tie a knot to hold the spoon in place.

With your finger tips hold the ends of the string in your ears, one in each and bend forward so that the spoon and the string hang freely *(Fig 20)*.

Let a friend strike the spoon with another spoon or a nail *lightly*.

What do you hear?

You hear loud sounds as if a bell is ringing.

Do you know why?

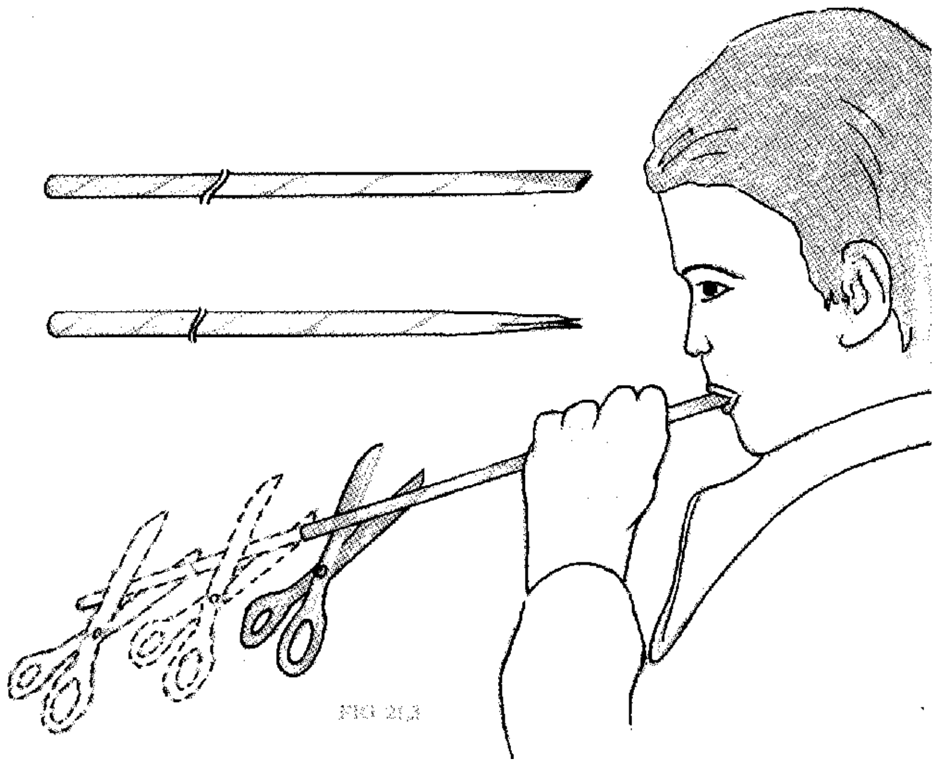
You can hear amazingly beautiful sounds depending on the spoon and how it is struck. You can hang a spoon and a fork, a spoon and a knife, *etc.*

21 Straw Flute

Materials

Drinking straw

Pair of scissors



With the thumb and fore-finger pinch a length of about 2 cm from an end of a drinking straw such that the end becomes flat *(Fig 21.1)*.

Cut off the corners of the flat end with a pair of scissors *(Fig 21.2)*.

The flat end can be used as the reed of a wind instrument. Blow *gently* through the reed and adjust so that the reed vibrates.

What happens?

You hear a soft sound out of the straw.

It may take a little practice to find out how hard to blow and how to adjust the reed.

Where does the note come from?

Cut off the other end of the straw about 2 cm at a time and each time ‘play’ on the straw *(Fig 21.3)*.

What happens to the sound note?

The shrillness (pitch) of the note produced keeps on increasing as you decrease the length of the straw.

Why?

Now tune individual straws, by cutting them suitably, to different musical notes: Sa, re, ga, ma, *etc.*

Next work on a single straw and make holes at proper lengths. You have a straw flute.

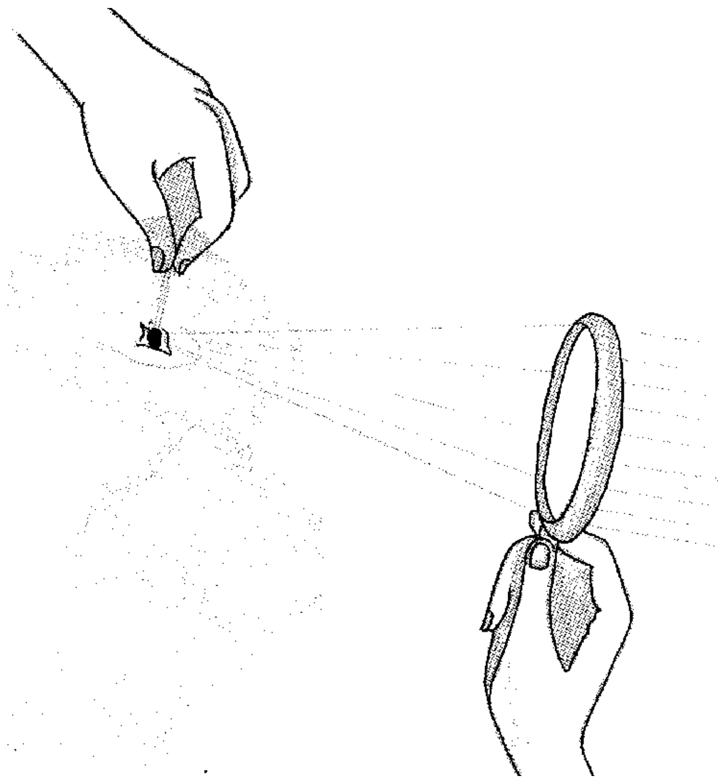
22 Light a Match Stick without a Match Box

Materials

Box of matches

Reading lens (Magnifying glass)

Sunlight



Hold a match stick in your left hand,

Hold a magnifying glass in your right hand. Move it to and fro in sunlight till an image of the sun is formed on the tip of the match.

Wait for some time and watch. What happens?

In a few seconds, the match-head lights up without you striking it against a match box *(Fig 22)*.

Do you know why?

23 Newton's Disc

Materials

Pair of compasses

Pair of scissors

Cardboard

White paper

Gum

Colours (water or oil or crayon)

Spinning top, the kind with disc (ordinary wooden one will do)

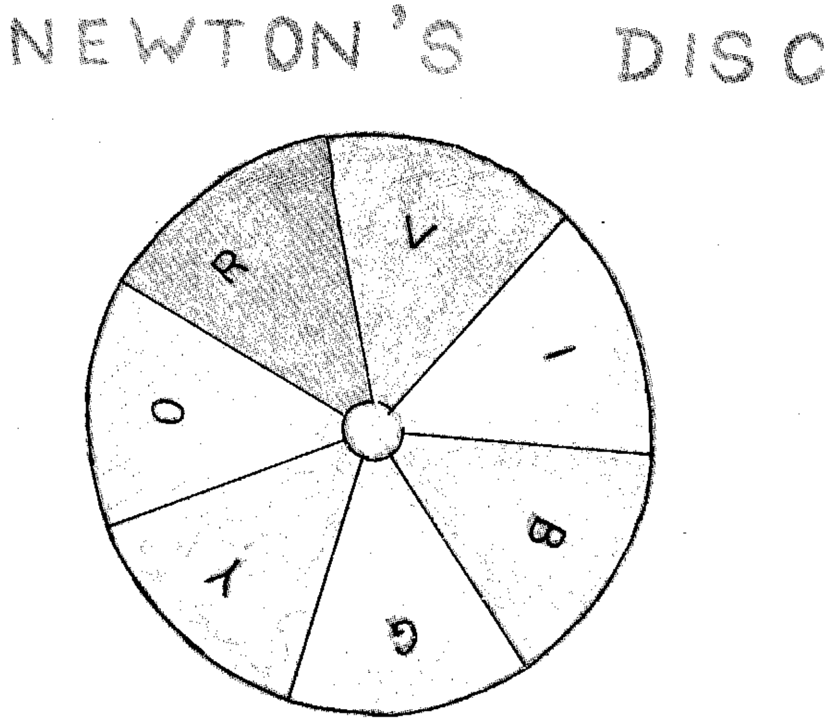


FIG 23.1

Cut out a circle of cardboard about 5 cm in diameter and a circle of white drawing paper of the same size as the cardboard.

Carefully paste the paper on the cardboard. Divide the paper side into seven nearly equal parts.

Use colours to paint each of the parts with one colour of the rainbow in the order VIBGYOR*.

Newton's disc is ready *(Fig 23.1).*

Make a hole at the centre of the coloured circle. Fix it to the rod of a spinning top with the coloured side facing upwards.

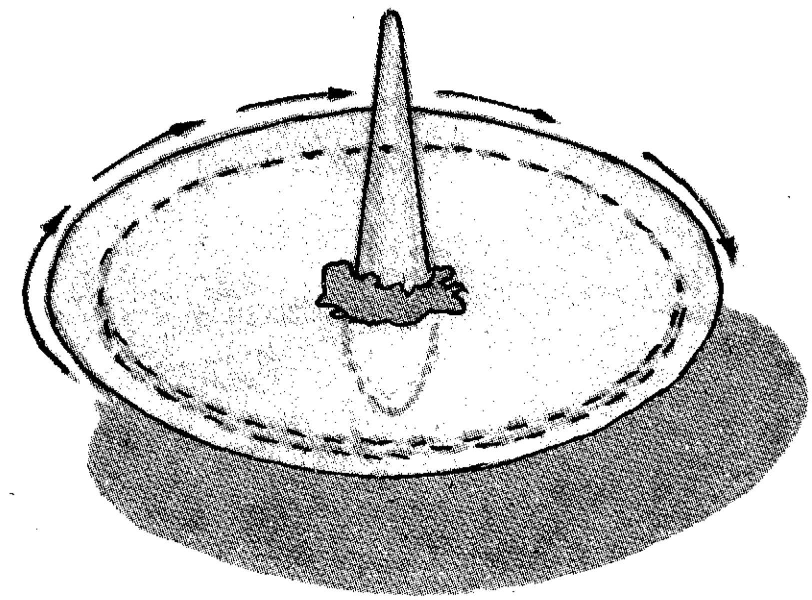


FIG 23.2

*V — violet, I — Indigo, B — Blue, G — Green, Y — Yellow, O — Orange, R — Red.

Spin the top.

What is the colour of the spinning disc?

When the disc spins *fast,* it looks white *(Fig 23.2).*

When the disc spins slowly, you can see the different colours.

Why?

24 Sita runs away from Ravana but runs towards Rama

Materials

Pencil

Suction cup (sold as 'valve grinder')*

Small test tube (glass or plastic)

Plasticine

Two bar magnets

Thick paper

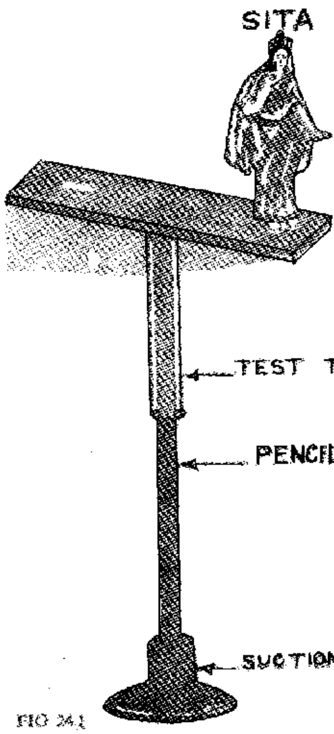


FIG 24.1

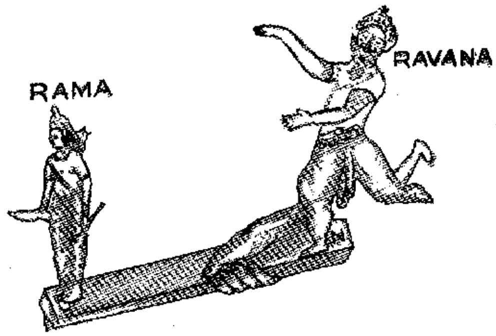


FIG 24.2

Hold a well sharpened pencil in a suction cup. Support a small glass test tube over the pencil point. Secure a bar magnet to the inverted base of the test tube with some plasticine.

Press the suction cup against a smooth table surface. Use a little water, if necessary *(Fig 24.1)*.

The bar magnet is now free to rotate about the pencil and will come to rest in the N-S position.

Make paper drawings of Rama, Sita and Ravana.

Paste Sita on the supported magnet; say at the N-seeking pole.

* An empty thread reel works equally well.

Take another bar magnet and cover it completely with paper. Then paste Ram at the S-seeking pole and Ravana at the N-seeking pole *(Fig 24.2)*.

Let Ravana approach Sita.

Sita runs *away.*

Let Rama approach Sita.

Sita runs *towards* him.

Do you know how this happens?

25 Magnet floats in Air

Materials

Two similar strong bar magnets Piece of wood

Plasticine (or any modelling clay) Toothpicks (or match sticks)

Take two identical strong bar magnets.

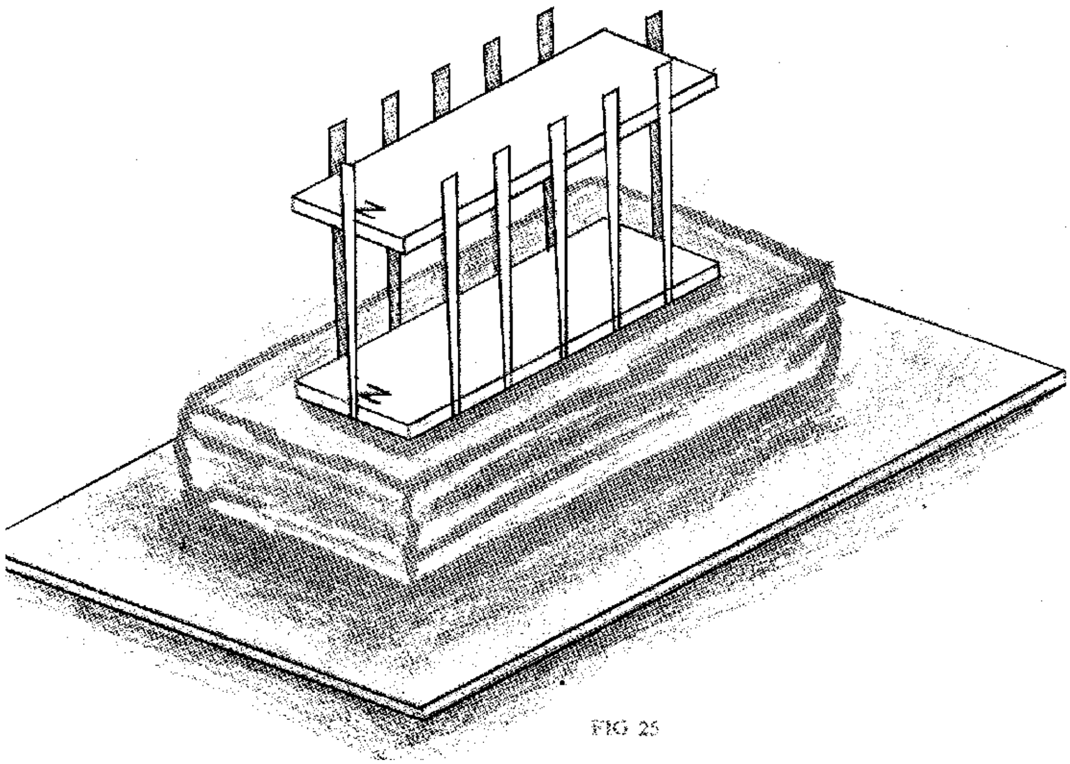


FIG 25

On a piece of wood, press some plasticine into a rectangular shape larger than the size of the magnets.

Place one of the magnets on the plasticine block. Press a few toothpicks into the plasticine and around the sides and edges of the magnet and just touching it.

Now place the other magnet into the frame of the toothpicks with its N-seeking pole above the N-seeking pole of the first magnet *(Fig 25)*.

What do you see?

The upper magnet remains suspended in the air.

Do you know why?

26 Make a Sensitive Current Detector

Materials

Pocket compass

Enamelled copper wire

Cardboard (preferably corrugated)

Drawing pins

Connecting wire

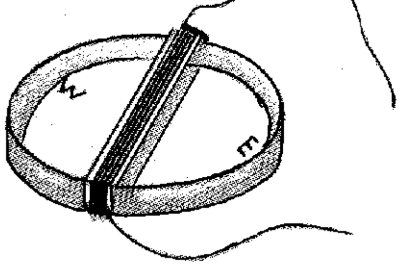


FIG 26.3

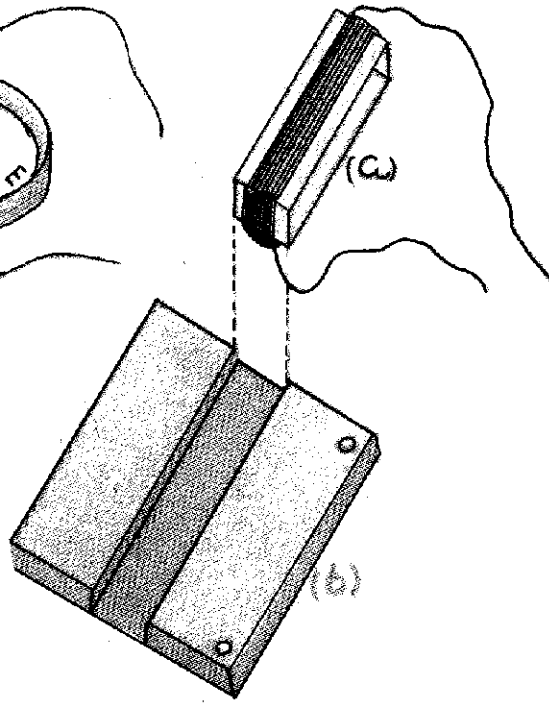


FIG 26.2

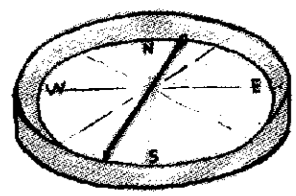


FIG 26.1

Take a pocket compass *(Fig 26.1)*.

Bend a narrow strip of cardboard around the compass. Remove the rectangular hollow piece so formed and wind 60 to 70 turns of enamelled wire around it *(Fig 26.2a)*. (The cardboard piece is now called the *former* of the coil).

From corrugated cardboard make a base with a groove in which the lower part of the coiled wire and cardboard strip will sit well *(Fig26.2b)*.

Replace the coil with its former over the compass *(Fig 26.3)*.

The compass should now comfortably rest on the cardboard base Turn the base (and with it the compass itself) so that the coil is parallel to the magnetic needle. The axis of the coil of wire will now be E-W.

Fix two drawing pins to the base and connect the ends of the coil of wire one to each pin.

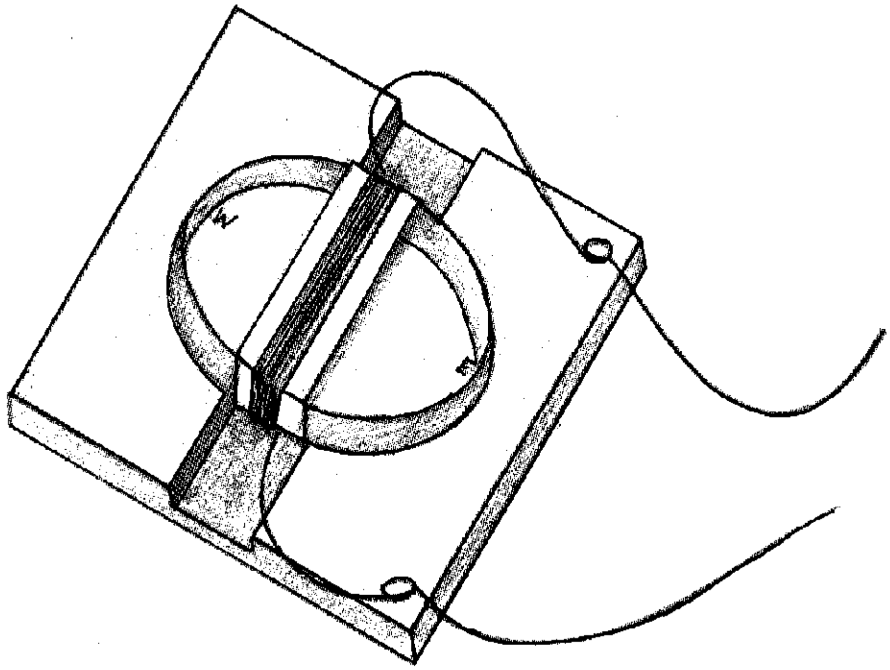


FIG 26.4

Connect two wires to the two pins after scraping enamel off 1 cm from each end.

The free ends of these two wires will be the terminals of the detector *(Fig 26.4)*.

The current detector is ready. It is quite sensitive.

Whenever there is a current in the wire the compass needle will be deflected. The stronger the current is the greater will the deflection be.

Why?

27 Ball Bearing Model

Materials

Tree bottle caps of different sizes

Marbles

Book

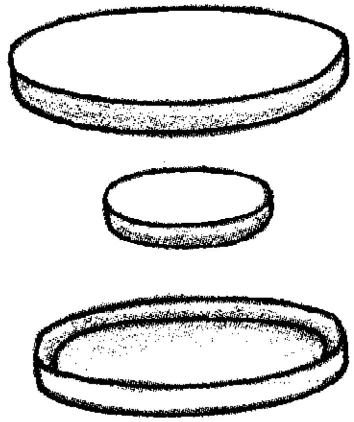


FIG 27.1

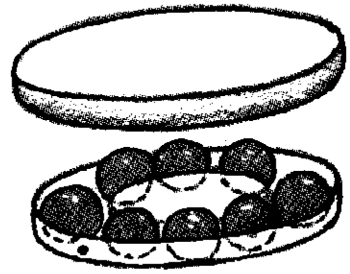


FIG 27.2

FIG 27.3

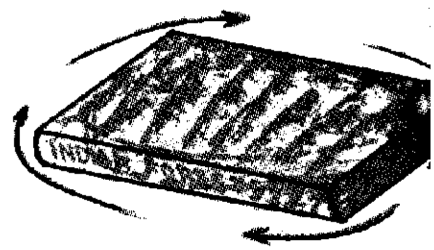
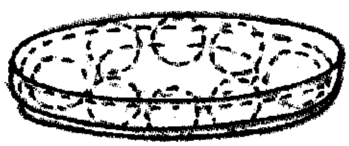


FIG 27.4



Take three screw-on bottle caps of different sizes *(Fig 27.1)*.

Put the smallest cap inside the middle-size cap. Take marbles of the same size and put them between the edges of the two caps. You now have a ring of marbles *(Fig 27.2)*

Place the largest cap such that it rests on the marbles only and does not touch any of the other caps or the table *(Fig 27.3)*.

You have made a model of a ball bearing.

Keep a book on the largest cap and spin it. The book will turn easily *(Fig 2 7.4)*.

Why?

Next take out the marbles. Keep the top cap back and place the book on it. Try to spin the book again. It will not spin. It may move a little.

Why?

28 Egg-shell is much stronger than it seems

Materials

Egg shells

Sharp scissors

Piece of cloth

Some books

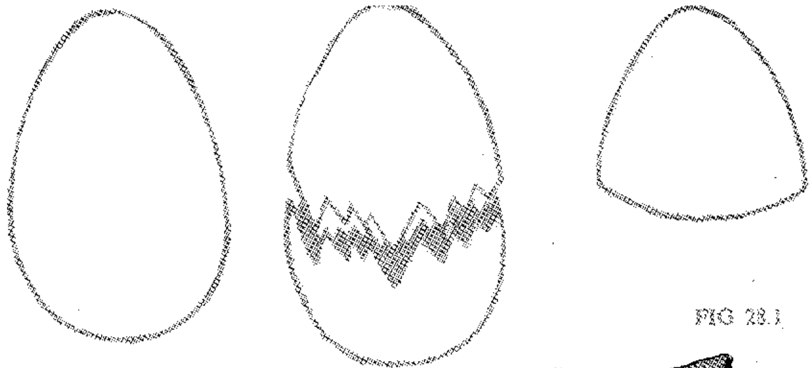


FIG 28.1

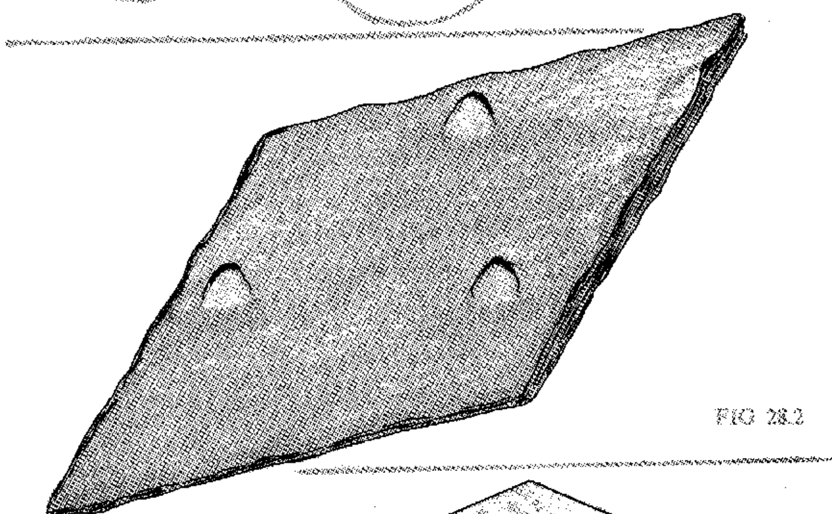


FIG 28.2

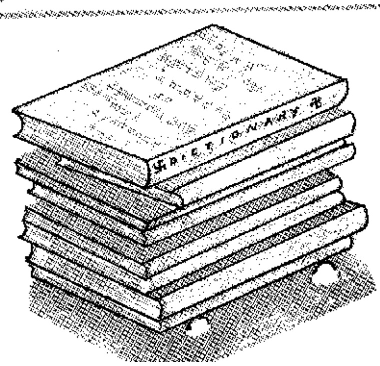


FIG 28.3

Take half an egg-shell. Using sharp scissors chip carefully all around to form an even edge. Do it bit by bit *(Fig 28.1)*.

Prepare two more half egg-shells.

Fold a piece of cloth. Lay the three half shells with their open sides on the cloth *(Fig 28.2.)*

Keep a book on the three shells.

Are you surprised?
The shells do not crush.
Pile up more books carefully, one at a time *(Fig28.3)*.
Find out how many books are needed to crush the shells.
You may be able to pile 8 to 10 books before the shells crush.
The thin egg shell did not seem to be strong, did it?
Why?

29 Make a Fire Extinguisher

Materials

Bottle
Cork to fit the bottle
Glass tube
Rubber tube
Water
Acetic acid (or vinegar)
Candles
Box of matches
Empty box
Sodium bicarbonate

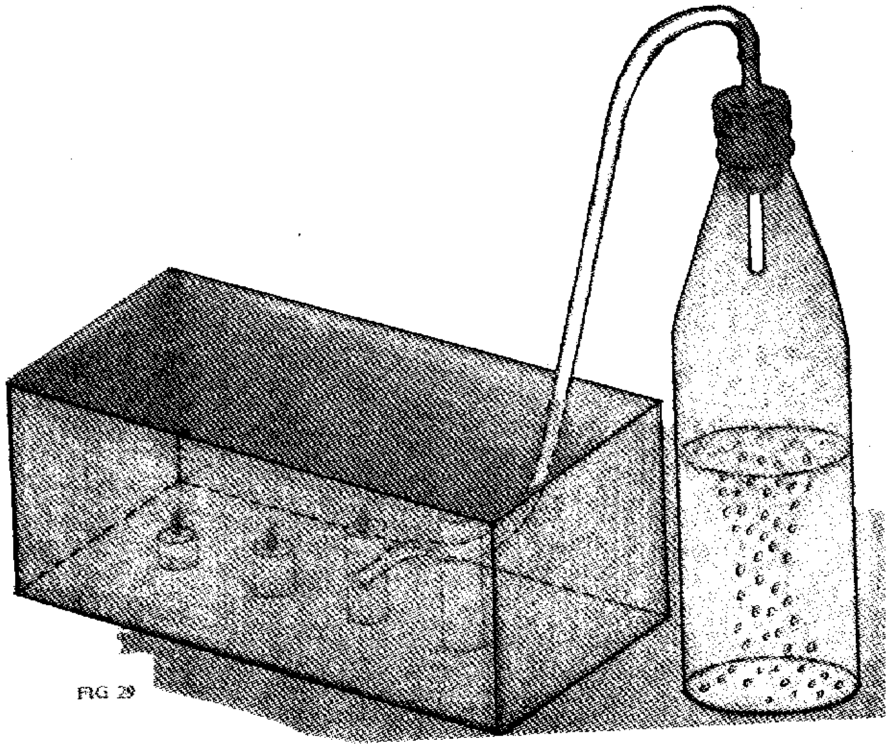


FIG 29

Take a bottle with a well fitting cork. Make a hole in the cork so that a glass tube can pass through. Attach a rubber tube to the glass tube.

Fill the bottle about half with water. Add a teaspoonful of acetic acid to it and shake the water. (A solution with equal proportions of vinegar and water works well.)

Light a few candles of different heights placed in a box.

Add a teaspoonful of sodium bicarbonate to the solution and quickly cork the bottle. Make sure that the cork fits firmly.

What happens?

The bottle is filled with bubbles of gas.

Why?

Direct the current of the gas towards the candles.

What do you see?

The candles go off one by one, the shortest one going out first.

Why?

30 Arm-muscle Motion Model

Materials

Boxwood or plywood

Handsaw

File

Hinge

Screws and screw-driver

Four screw-eyes

Two long balloons

String

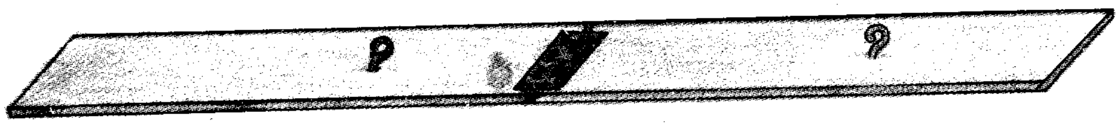


FIG 30.1

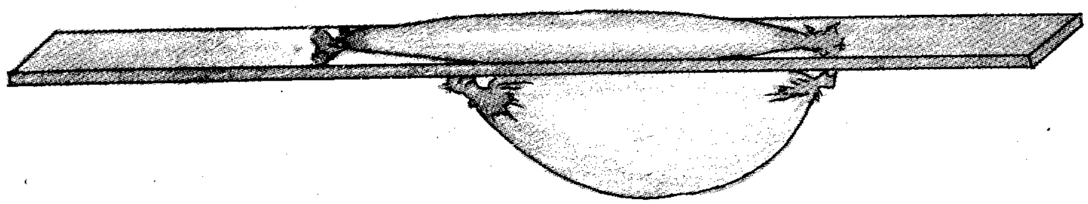


FIG 30.2

Using a handsaw, cut out two wooden boards 30 cm x 5 cm and file the edges to be nice and smooth.

Join the two boards along the breadth by a hinge. The boards represent the arm bones and the hinge, the elbow, the hinge side, the inside (or *front)* of the arm and the back, the elbow side.

On the front side of one of the boards fix a screw-eye about 5cm from the hinge and another on the back side as close to the hinge as possible. This board represents the lower arm-bone.

Screw in the other two screw-eyes in the other board (upper arm-bone) on the front and the back about 20 cm from the hinge *(Fig 30.1).*

Blow air into two long balloons and tie a short length of string each to the necks and the bottoms of the balloons. Tie the other ends of the strings to the screw-eyes such that the ends of the balloons are as close to the screw-eyes as possible. The upper balloon represents the muscle in the front arm (biceps) and the lower balloon, the muscle in the back of the arm (triceps)*.

Straighten the boards. What happens?

The upper balloon contracts (sideways), the lower one expands *(Fig 30.2).*

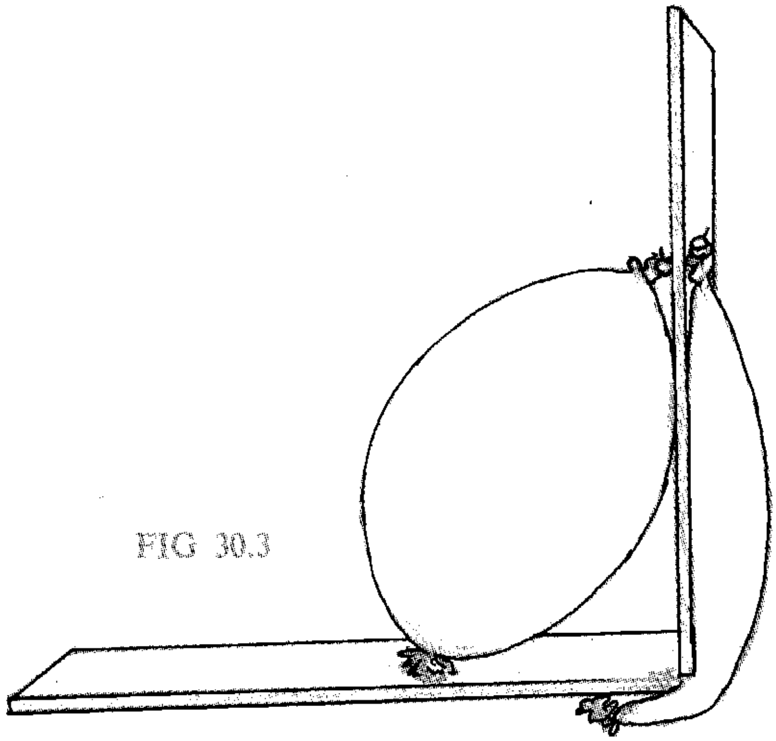


FIG 30.3

Bring the two boards to be at an angle with each other. What do you see?

The upper balloon expands, the lower one contracts *(Fig 30.3)*. Every time when one muscle contracts, the other expands.

It should be noted that in the model when the bone (board) is moved, then the muscle (balloon) moves, whereas in the actual arm, the muscle contracts/expands and then the bone moves.

* Actually the lower arm has two bones and triceps has three points of attachment. We have simplified the whole thing a little.

Explanations of Activities

1 Air is real and has weight. Filling the football bladder with air makes it heavier.

2 Air expands on heating and contracts on cooling.

When the hot bottle is quickly plunged in cold water, the air pressure inside is *suddenly reduced* and the higher pressure outside, crushes the bottle.

As time passes, the outside higher pressure pushes the water through the small hole into the bottle slowly. This goes on till the pressure inside

becomes equal to the pressure outside and the bottle returns to original shape.

3 The water remains in the inverted tumbler because the pressure of the air outside the glass against the card is greater than the pressure of the water against the card.

4 The burning matches use a part of the air. Hence the pressure inside the bottle is reduced. The outside air, being at a higher pressure, pushes the egg in.

5 The pressure of moving air is smaller. So the pressure of air above the balloon decreases and the air below pushes the latter up.

An aeroplane gets its lift in exactly the same way. The shape of the wings is such that the air moves faster over the top of the wings, thus reducing the pressure. The air below is at a greater pressure and lifts the wings up.

6 Moving air above the card has lower pressure. Air below at higher pressure keeps the card in place.

7 Moving air that strikes a flat surface causes irregular air currents on the other side as it leaks around the edges. The flame bends towards the square card because of their disturbance (turbulence).

A stream of air that flows round a streamlined surface flows *smoothly* in the same direction from which it is coming and causes little turbulence.

Racing car designers curve the front end in such a manner that it will cut the air. The rear end is tapered so that the air will flow around it and not be sucked back towards the car.

Aeroplane wings have a round leading edge so that the air flows smoothly over and under them with little turbulence.

Thus streamlining helps vehicles slip through air without too much resistance.

8 The air escapes from the mouth of the balloon in one direction and the box moves in the opposite direction. This is exactly the principle of the jet aeroplanes and rockets. The pencils act as rollers and reduce the friction between the box and the table (see Activity 29 Book II).

9 The stretched rubber band has energy. When the string burns, the rubber band contracts and thus pushes the stone forward. This gives rise to a reaction force that moves the gun backward.

Catapults with which children shoot at birds work exactly on the same principle.

10 Action and reaction are equal and opposite. Hence the car moves one way and the road moves the other way. Every time you take a step forward you push the earth backward. It is not possible to see this movement because it is very small since the earth is so HUGE.

11 As the obedient tin rolls, the heavy weight tries to remain hanging down. This causes the rubber band to wind up. The winding goes en up to a point (depending on the force used to roll the tin), the rubber band unwinds itself and the tin slowly returns to you.

12 The stick balances when the fingers come right under the centre of gravity of the stick. As the metre stick is uniform the centre of gravity is at the centre.

13 Loading the tin shifts the centre of gravity of the system near to the weight. The CG always tries to lower its position. Since we hold the tin with the weight high and *towards uphill,* the tin rolls up so as to lower it. On a flat surface the tin will roll similarly.

14 Rubber is an *exception* to the Law of Expansion which says 'Heat expands cold contracts'. The Law should be: 'In general, heat expands cold contracts'. Many plastics behave like rubber. Try them. This is because these substances are made of very long molecules.

15 In solids, heat travels from layer to layer (conduction). It first reaches the first wax ball, then the next, and the next, and so on.

16 Cold water is heavier than hot water and goes down. Hot water is lighter and goes up. Similarly salt water is heavier and goes down and fresh water is lighter and goes up.

This is exactly how ocean currents are caused. In some seas the hot and cold water change places. In some others, more salty water and less salty water change places.

17 Heat expands liquids. Different liquids expand differently.

18 The heat of the flame changes the solid candle into a gas. It is the gaseous material that burns, not the solid candle. Immediately after you blow out the flame, the heated candle material is still around the wick of the candle. This is burnable (inflammable) whether the candle itself is lighted or not.

19 The sound vibrations are carried from the vocal cords by the air in the first tin to the bottom of the tin. From here the sound waves travel along the string to the bottom of the second tin. This sets the air in the second tin in vibration. These vibrations reach the ear drum and the sound is reproduced.

20 The sound that you hear is what is carried by the string rather than what is carried through the air. Solids carry sound waves better than air because spreading of sound energy is much less. Jungle-dwellers, men as well as animals, while tracking often put their ear to the ground for the same reason.

21 When you blow, the little reed moves up and down (vibrates) and thus allows more and then less air into the straw. The pressure within the air-column in the straw thus changes. This makes the air-column vibrate, *i.e.* produce the sound. The pitch of the note depends on the length of the air-column that vibrates. The longer the straw, the longer the air-column and softer the sound and *vice-versa.*

22 When you strike a match against a match box, friction produces heat. Here, the magnifying glass concentrates-the heat and the light of the sun on the tip of the match-stick. The tip becomes hot and, lights up.

Legend has it that the ancient Greek scientist Archimedes had thought of constructing a huge lens to concentrate sunlight on and thus burn enemy soldiers.

23 When the disc spins *slowly,* the image of any one colour disappears before the image of the next colour forms on the retina. Hence, you can see the different colours. When the disc spins *fast,* the images of the colours overlap on the retina because of persistence of vision (see Activity 21 Book II). The seven colours combine together to give the effect of white light.

24 Like magnetic poles repel, unlike magnetic poles attract.

25 Like magnetic poles repel. The force of repulsion keeps the upper magnet floating in air. It floats at a place where the magnetic force balances the force of gravity exactly. (The toothpicks only prevent the magnet from sideways movement.)

26 When there is a current in the coil a magnetic field is produced along its axis. The magnetic needle gets deflected under the *combined* action of the field due to current (E-W) and the earth's field (N-S),

27 Marbles act like steel balls in the bearings of a wheel. Ball bearings reduce the friction between the axle and the wheel because, firstly, the area of contact between moving parts is very small and secondly, the balls also rotate.

28 The egg shell gets its strength from its curved shape. The hen sitting on the eggs, thus, need not fear that the egg will be crushed by the weight of its body.

Some modern buildings use thin shell construction and combine lightness and strength with beauty.

29 When sodium bicarbonate and acetic acid come together, a chemical reaction takes place and carbon dioxide gas is formed. It is heavier than air and goes to the bottom of the box. Hence, as more and more gas enters the box, the oxygen is gradually replaced by carbon dioxide and the candles cannot burn further. As the latter is heavier, the first candle to go out is the shortest one.

Fire extinguishers work on the same principle. Modern fire extinguishers direct a non-burning foam into the fire.

End